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QUARTERLY REPORT

Project Title: Performance Evaluation of High-Strength Steel Pipelines for High-Pressure Gaseous Hydrogen Transportation

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Project #294: Performance Evaluation of High-Strength Steel Pipelines for High-Pressure Gaseous Hydrogen Transportation

Background

Hydrogen is being considered as a promising candidate for alternative fuels. One key component of the hydrogen infrastructure is the delivery systems from the point of production to the point of use. Transporting gaseous hydrogen via existing pipelines is recognized as one of the most cost-effective options for delivering large volume of hydrogen. One of the major safety concerns has been performance degradation of pipeline materials under a high-pressure hydrogen environment. With extended exposure to high-pressure hydrogen, the mechanical properties of pipeline steels, including their tensile and yield strengths, fracture toughness, and crack-growth rate, may deteriorate. This could lead to significant reduction of service life of pipeline. As more and more high-strength pipelines have been put into service, there is a need for materials performance data under high-pressure hydrogen environment for high-strength steels. This project is intended to address these challenges. The objectives of this project are to produce performance data for high-strength steels used in hydrogen pipelines, use mechanistic-based analysis procedures and models for correlating the test data and predicting material behaviors under practical conditions. The test data and the analysis results will be used to enable updates and revisions of relevant industrial codes and standards.

Progress in the Quarter

The project activities undertaken through the second quarter focused on Task 1, Model Development, Task 2, Development of Test Equipment, and Task 4, Test Matrix Design. Major development on project management is the addition of Louis Hayden of ASME to the project core team as a consultant and project coordinator.

The first part of Task 1 is to conduct literature review on the mechanisms of hydrogen embrittlement of metals, collect existing performance data for pipelines steels under hydrogen environments. This part has been completed. The second phase of this task is to develop a mechanism-based model procedure to predict the hydrogen embattlement for pipeline steels under a pressurized hydrogen environment. Model inputs on test materials, test conditions, and specimen dimensions are established based on the preliminary test designs via Tasks 2 and 4.

Tasks 2 and 4 have been started at NIST. The designs of new hydrogen test chamber, the specimen, and the clevis have been finalized. The preliminary design of the link structure to accommodate simultaneous testing of 10 specimens has been done. Discussions on the link structure design among team members are under way. The initial test matrix design has been developed by NIST. Several rounds of discussions by the project team have been hold to finalize the test matrix.

Louis Hayden of ASME joined the project core team and acts as a consultant and project coordinator. He will provide consulting on materials to be tested, test matrix finalization, review of test procedures and expected outcomes and guide the project to produce results that are usable for the revision of ASME B31.12 Hydrogen Piping and Pipeline Code. Additionally Hayden will provide coordination and guidance between this project and a similar DOT project being executed by The University of Tennessee and Oakridge National Laboratory.